

- 1 1. An apparatus for asynchronous file-based replication of a hierarchically-indexed data  
2 store, the apparatus comprising:
  - 3 a replication source comprising a hierarchically-indexed data store;
  - 4 a tracking module configured to track file regions that have changed since a first  
5 point-in-time image replication instance; and
  - 6 a replication module configured to communicate data contained within changed file  
7 regions in response to a second point-in-time image replication instance.
- 8
- 9 2. The apparatus of claim 1, further comprising a replication target configured to receive  
10 the data contained within the changed file regions from the replication source, write the data  
11 within corresponding files regions on the replication target, and initiate a point-in-time image  
12 replication operation configured to synchronize the replication target with the replication  
13 source.
- 14
- 15 3. The apparatus of claim 1, wherein the replication module is further configured to  
16 communicate the data contained within the changed file regions in an order that is  
17 independent of a change order.
- 18
- 19 4. The apparatus of claim 1, wherein the replication module is further configured to  
20 conduct replication operations as directed by policies related to replication.
- 21
- 22 5. The apparatus of claim 1, further comprising a storage management module configured  
23 to set policies related to replication.
- 24
- 25 6. The apparatus of claim 1, wherein the hierarchically-indexed data store comprises a  
26 hierarchical structure corresponding to a file system.
- 27

1 7. The apparatus of claim 1, further comprising a point-in-time image replication module  
2 configured to provide point-in-time image replication services to the heirarchically-indexed  
3 data store.

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5 8. The apparatus of claim 1, wherein the tracking module is further configured to save  
6 information regarding the file regions that have changed since the first point-in-time image  
7 replication instance.

8  
9 9. The apparatus of claim 1, wherein the tracking module comprises a file system driver.

10  
11 10. The apparatus of claim 8, wherein the file system driver is an installable driver.

12  
13 11. The apparatus of claim 1, wherein the point-in-time image replication comprises a  
14 snapshot.

15  
16 12. An apparatus for asynchronous file-based replication of a hierarchically-indexed data  
17 store, the apparatus comprising:

18 a replication target comprising a hierarchically-indexed data store;

19 an update module configured to receive data within file regions changed on a  
20 replication source during a previous point-in-time image replication interval;

21 the update module further configured to write the data within corresponding files  
22 regions on the replication target; and

23 the update module further configured to initiate a point-in-time image replication  
24 operation configured to synchronize the replication target with the replication source.

25  
26 13. The apparatus of claim 12, further comprising a tracking module configured to track file  
27 regions that have changed on the replication source since a first point-in-time image

1 replication instance, and a replication module configured to communicate data contained  
2 within changed file regions in response to a second point-in-time image replication instance.

3  
4 14. A method for asynchronous file-based replication of a hierarchically-indexed data store,  
5 the method comprising:

6 storing data on a hierarchically-indexed data store;

7 tracking file regions that have changed since a first point-in-time image replication  
8 instance; and

9 communicating data contained within changed file regions in response to a second  
10 point-in-time image replication instance.

11  
12 15. The method of claim 14, further comprising receiving data within the changed file  
13 regions from a replication source, writing the data within corresponding files regions on a  
14 replication target, and initiating a point-in-time image replication operation configured to  
15 synchronize the replication target with the replication source.

16  
17 16. An apparatus for asynchronous file-based replication of a hierarchically-indexed data  
18 store, the apparatus comprising:

19 means for storing data on a hierarchically-indexed data store;

20 means for tracking file regions that have changed since a first point-in-time image  
21 replication instance; and

22 means for communicating data contained within changed file regions in response to a  
23 second point-in-time image replication instance.

24  
25 17. The apparatus of claim 16, further comprising means for receiving data within the  
26 changed file regions from a replication source, means for writing the data within  
27 corresponding files regions on a replication target, and means for initiating a point-in-time

1 image replication operation configured to synchronize the replication target with the  
2 replication source.

3  
4 18. A system for asynchronous file-based replication of a hierarchically-indexed data store,  
5 the system comprising:

6 a replication target comprising a CPU and a first hierarchically-indexed data store ;

7 a replication source comprising a CPU and a second hierarchically-indexed data  
8 store;

9 a tracking module configured to track file regions that have changed on the  
10 replication source since a first point-in-time image replication instance; and

11 a replication module configured to communicate data within changed file regions to  
12 the replication target in response to a second point-in-time image replication instance.

13  
14 19. The system of claim 18, wherein the replication target is further configured to receive  
15 the data within changed file regions from the replication source, write the data within  
16 corresponding files regions on the replication target and initiate a point-in-time image  
17 replication operation configured to synchronize the replication target with the replication  
18 source.

19  
20 20. The system of claim 18, wherein the replication module is further configured to  
21 communicate data contained within the changed file regions by communicating the data in an  
22 order that is independent of a write order.

1 21. A computer readable storage medium storing computer readable program code for  
2 conducting a method for asynchronous file-based replication of a hierarchically-indexed data  
3 store, the method comprising:

4       storing data on a hierarchically-indexed data store;  
5       tracking file regions that have changed since a first point-in-time image replication  
6 instance;  
7       communicating data contained within changed file regions in response to a second  
8 point-in-time image replication instance; and  
9       synchronizing with a replication target via a standard point-in-time image replication  
10 operation.

11  
12 22. The computer readable storage medium of claim 21, wherein the method further  
13 comprises receiving data within the changed file regions from a replication source, writing  
14 the data within corresponding files regions on a replication target, and initiating a point-in-  
15 time image replication operation configured to synchronize the replication target with the  
16 replication source.

17  
18 23. The computer readable storage medium of claim 21, wherein the method further  
19 comprises communicating data contained within the changed file regions comprises  
20 communicating the data in a order that is independent of a write order.

21  
22 24. The computer readable storage medium of claim 21, wherein the method further  
23 comprises communicating is conducted as directed by policies related to replication.

24  
25 25. The computer readable storage medium of claim 21, wherein the method further  
26 comprises invoking point-in-time image replication services.  
27

1 26. The computer readable storage medium of claim 21, wherein the method further  
2 comprises saving information regarding the file regions that have changed since the first  
3 point-in-time image replication instance.

4  
5 27. The computer readable storage medium of claim 21, wherein the method further  
6 comprises tracking file regions is conducted in response to write operations.

7  
8 28. The computer readable storage medium of claim 21, wherein the method further  
9 comprises saving information regarding the storage regions that have changed since the first  
10 point-in-time image replication instance.

11  
12 29. The computer readable storage medium of claim 21, wherein the point-in-time image  
13 comprises a snapshot.

14  
15 30. A change tracking data structure for use in conducting point-in-time replication  
16 operations, comprising

17 a block index configured to logically identify blocks associated with a selected  
18 volume;

19 a block address configured to indicate a physical location of a block within a storage  
20 device;

21 a status indicator configured to indicate whether a change has been made to a block  
22 since a previously conducted point-in-time replication operation; and

23 a file index configured to identify a file associated with a selected data block.  
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